Review

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Conservative management of displaced paediatric supracondylar fractures: a systematic review

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Abstract

In low-income countries, where surgical expertise and resources are limited, displaced supracondylar fractures of the distal humerus are routinely managed with traction or closed reduction and casting. This is in contrast to high-income nations, where percutaneous K-wire fixation forms the mainstay of treatment. The aim of our study is to present the published evidence regarding the outcome of conservatively managed displaced supracondylar fractures in children. A systematic review of the literature was performed identifying 46 studies evaluating the outcome of displaced supracondylar fractures managed non-operatively. Our results show management by traction is equivalent to percutaneous pinning, whereas outcomes following closed reduction and casting were inconsistent. Traction therefore remains a viable option in low- and middle-income countries (LMICs). However, at present there are few data from LMICs, limiting the transferability of our conclusions.

Keywords

Casting, conservative, paediatric, supracondylar, traction

Background

Supracondylar fractures of the distal humerus are the most common injury in children aged <7 years and constitute 18% of the fractures sustained by those aged <16 years.[1] Classification of such injuries is based on a system initially described by Gartland (Figure 1).[2] Undisplaced Gartland type I fractures are typically managed with cast immobilisation, resulting in good functional outcomes and are not the focus of this study.[3,4]

Historically, closed reduction and casting provided the mainstay of treatment; however, rates of Volkmann's ischaemic contracture were high.[5] In the 1920s, Dunlop began treating displaced supracondylar fractures with traction,[3] and by doing so, successfully reduced the frequency of serious complications.[6] However, long hospital stays and the inherent associated costs led to a shift in favour of operative management.[7]

In many LMICs, surgeons often lack access to resources or expertise for operative management.[8] Consequently, conservative management remains the norm.[9] In our institute at Queen Elizabeth Central Hospital, Blantyre, Malawi, straight-arm traction remains the mainstay of treatment for such injuries, with few observed complications.

In high-income countries, where surgical treatment is routine, options include open reduction and internal fixation (ORIF) or open/closed reduction with fixation by percutaneous Kirschner (K) wires. The American

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Association of Orthopaedic Surgeons (AAOS) recommends closed reduction with pin fixation for all patients with displaced injuries.[3] The British Orthopaedic Association Standards for Trauma (BOAST 11) recommends early surgical treatment for these injuries.[10]

There is no Level-1 evidence available comparing the outcomes of operative versus conservative management of these fractures. We present the published evidence.

Methods

A review of the literature was performed using the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) checklist and algorithm.[11] A search was conducted using the Medline, EMBASE and Cochrane computerised literature databases in July 2016. Inclusion and exclusion criteria are displayed in Table 1. No year of publication limits were applied and all English language studies were included.

We retrieved 795 results (Table 2). The flow diagram of articles included is outlined in Figure 2. Following review of abstracts, 35 were selected for full text review. A further three were excluded: one examined only humeral shaft fractures;[12] a second lateral condyle fractures;[13] and one contained no conservative intervention.[14] A further 14 articles meeting our inclusion criteria were identified through review of the reference lists. A data extraction table was formulated using Cochrane guidance, in which relevant information was collated from each full text included in the review including assessment of the risk of bias.[15]

Outcome was difficult to assess owing to the heterogeneity of the studies; Flynn's criteria were the most widely used and comparable outcome measure. All results were tabulated and grouped by method of intervention for ease of comparison. Two authors (DY and SG) performed both review of abstracts and data extraction of the included studies. A total of 46 articles was included for final review (Figure 2).

Results

A summary of the 46 articles included appears in Appendices 1–4. Country income level is based on World Bank classification as of 1 January 2017.[16]

Closed reduction and casting

We found 28 studies examining outcome data of closed reduction and casting for displaced supracondylar fractures.[17–43] This included any method of immobilisation whereby plaster of Paris was applied to the injured arm, set under any degree of flexion. Closed reduction was performed and, where specified, manipulation of the displaced injury was performed under general anaesthetic, local block or sedation.

The most commonly used outcome measure was Flynn's criteria which evaluates both cosmetic and functional outcomes. The remainder used other functional criteria, radiographic evaluation or re-operation rate following failure of plaster cast immobilisation. Owing to the heterogeneity of the outcomes amongst the studies in question, we did not to compare them quantitatively.

Four studies found casting to be viable first line management.[9,26,28,43] However, all acknowledged a proportion who would require delayed pinning in the event reduction was lost; this was not found to affect long-term outcomes. These papers did not differentiate between Gartland types II and III.

Overall, inconsistent outcomes following closed reduction and casting makes it challenging to draw broad conclusions from the data in our review. Although a number of articles continue to advocate the method, especially in a low-income setting,[43] others suggest operative fixation provides superior outcomes.[32,37] In two articles, when a distinction was drawn between Gartland type II and III injuries, casting was found to provide unsatisfactory outcome in type III, but good results in type II.[32,37]

Table 1. An outline of inclusion and exclusion criteria used in our review.

Inclusion criteria	Exclusion criteria
1. Paper written in English	1. Undisplaced supracondylar fractures included in study
2. Level I, II, III or IV study design by *Journal of Bone and Joint Surgery* criteria	
3. Series reporting on supracondylar fractures of Gartland types II or III (displaced)	
4. Conservative (non-operative) management in one or all arms of the study	
5. Assessment of outcome (functional, anatomical or radiological)	
6. All patients in the study were aged < 18 years	

Table 2. Example of search criteria used in our review in Medline.

No.	Search term	Number of results
1	(supracondylar adj3 fractur*).ti,ab.	2095
2	(supracondylar adj3 (break* or broken)).ti,ab.	3
3	1 or 2	2095
4	Conservative Treatment/	317
5	(conservativ* adj3 (manag* or treat* or therap*)).ti,ab.	67,170
6	nonsurgical*.ti,ab.	13,850
7	non surgical*.ti,ab.	10,120
8	closed reduction*.ti,ab.	4547
9	plaster external traction.ti,ab.	1
10	Watchful Waiting/	2480
11	(watchful* adj3 wait*).ti,ab.	2163
12	(watchful* adj3 expectan*).ti,ab.	37
13	traction.ti,ab.	16,040
14	(conservativ* adj3 (manner* or method* or measur*)).ti,ab.	5348
15	nonoperativ*.ti,ab.	10,399
16	non operativ*.ti,ab.	4713
17	((cast* or plaster* or sling*) adj3 (immobolis* or immobiliz*)).ti,ab.	1849
18	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	129,449
19	3 and 18	578

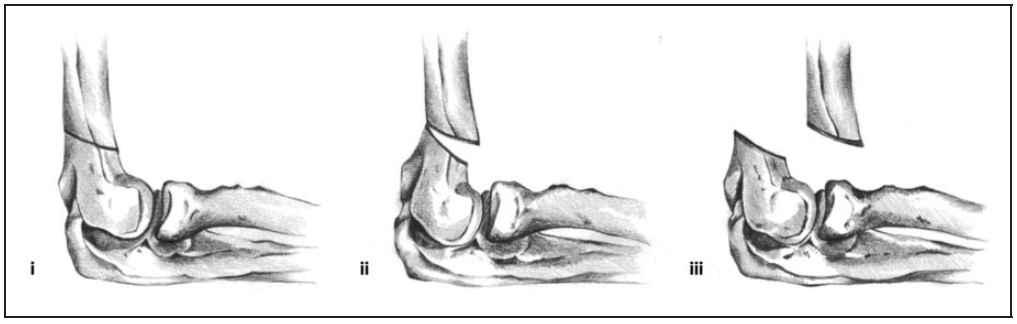

Figure 1. Lateral views of supracondylar fractures according to the Gartland classification: (i) type 1 (undisplaced); (ii) type 2; and (iii) type 3.

Traction

We found 24 studies presenting outcome data following traction as management of displaced supracondylar fracture.[8,18,22,28–30,36,39,41,42,44–56] Outcomes of overhead skeletal traction straight-arm lateral traction, skin traction, side arm traction and brace with traction were all examined and results displayed in appendices 1, 2 and 3.

When compared directly to operative intervention for comparison, traction resulted in equivalent outcomes.[18,28,36,41,42,53,54] Sutton et al. presented a retrospective case series (n = 65) directly comparing traction with percutaneous pinning.[53] Using Flynn's criteria as their principal outcome measure, they concluded no statistical difference when comparing the two methods.[53] However, they did not state the grading of Gartland fracture between the two treatment groups. Where cost of treatment was assessed, traction was more expensive than operative intervention; hence, two papers concluding percutaneous pinning to be their preferred option.[8,53]

A total of 16 papers studied the outcomes of skeletal traction; of these, eight used Flynn's criteria as their primary outcome measure. Eight studies examined straight arm traction, two of which used Flynn's criteria. There was no statistically significant difference when compared directly. One paper did not specify the method of traction used.[41] One paper concluded

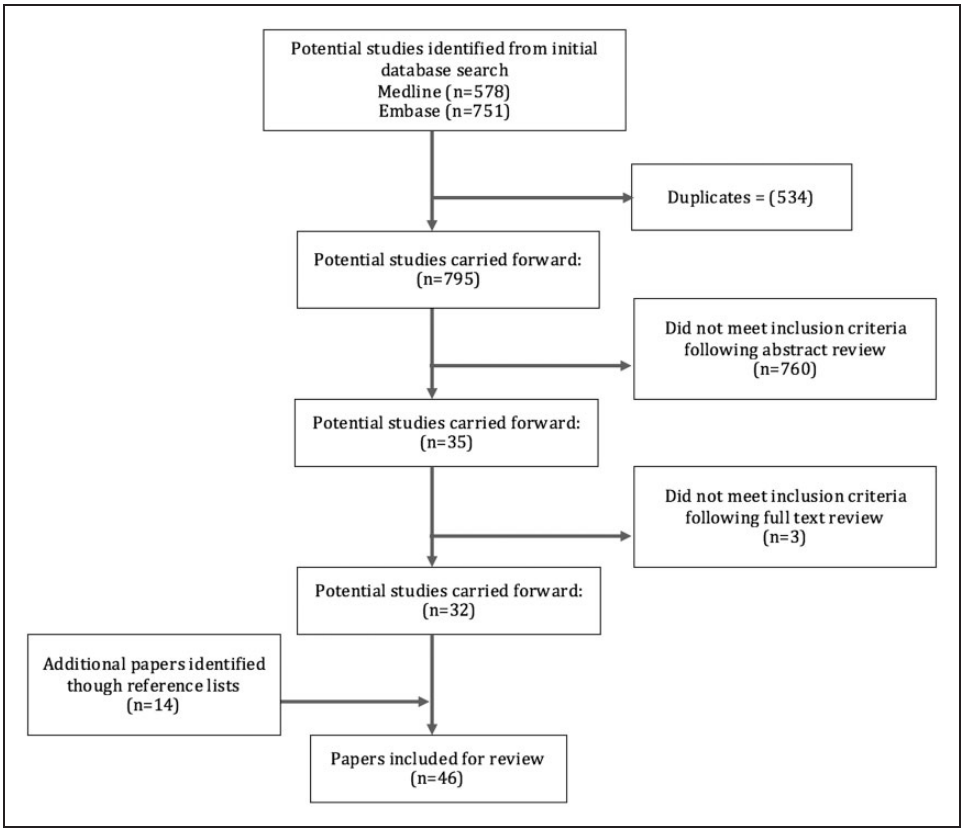

Figure 2. Flow diagram outlining studies included for review.

traction to have superior outcomes to casting, pinning and ORIF.[22] All 11 studies examining traction without operative intervention found it to provide excellent outcomes in severely displaced or swollen injuries. No patients managed with traction required subsequent operative intervention.[45–49,51,52,55,56]

Conclusion

Our review has shown that current evidence for the management of displaced supracondylar fractures is inconclusive. It appears that closed reduction and casting may be utilised in the first instance with positive results, with the option of percutaneous pinning in the event of failed reduction. Whereas outcomes following traction appear to be equivalent to that of percutaneous pinning, this conclusion is drawn from a limited number of studies. Despite this, the trend of managing all displaced injuries operatively within high-income setting remains unchallenged. Where resources allow, operative intervention is now regarded as the gold standard management for Gartland II and III injuries.[3] The British Orthopaedic Association Standards for Trauma state that displaced supracondylar fractures '*...require early surgical treatment; ideally on the day of admission... surgical stabilisation should be with bicortical wire fixation*.'[5] However, these are guidelines and cannot be translated to healthcare provision in resource-limited settings. The results of this review suggest that where surgical intervention is unavailable, such as in Malawi, traction remains the preferred management.

Anatomical reduction is required for percutaneous pinning to succeed.[3] Hence, attempting the procedure without the aid of intraoperative fluoroscopy would be hazardous, limiting its use to environments where such resources are available. Complications such as ulnar nerve injury, pin migration and pin tract infection are reported in the literature with rates in the range of 1.8–4.7%.[57–59] O'Hara et al. report rates of cubitus varus deformity of up to 32% when protocol and X-ray are not strictly followed with K-wire insertion.[33] There is therefore a trade-off between conservative management, where possible mild malunion would result in normal function but a potential cosmetic problem, and operative intervention where the intra- and postoperative complications can be significantly worse.

It is not only the access to surgical skills and equipment that limit the use of operative intervention in LMICs. Access to anaesthesia is a problem throughout sub-Saharan Africa, where facilities to deliver safe anaesthesia to children have been reported to be as

low as 13%.[58] This additional risk of operative intervention provides us with further insight as to why traction remains the preferred method of treatment in many countries.

There were no cases of Volkmann's ischaemic contracture in the papers included within our review. Loss of reduction was the only indication reported in the four studies recommending initial closed reduction with subsequent operative intervention.

The disparity between outcome measures used gives our data limited transferability. Although Flynn's criteria were used the most frequently, outcome measures in the literature are wide-ranging.[59] Flynn provides a method of analysis whereby results can be easily compared using change in carrying angle and range of motion. However, this clinical outcome is not patient-reported and can be prone to measurement bias. Changes in carrying angle, associated with a poorer score of Flynn's criteria, may not always equate with a worse functional outcome. There is a need for a validated functional outcome measure in children, encompassing patient-reported outcome measures.

One limitation of many articles in our review is the lack of transparency when allocating patients to treatment groups. It was frequently unclear how patients had been selected to be managed conservatively or operatively. Indeed, in retrospective case series, this cannot accurately be measured. Recruitment bias may well therefore have confounded several authors' conclusions.

Cubitus varus is widely considered a cosmetic problem, usually only evident when standing in the anatomical position.[60] Review of patients with residual cubitus varus following supracondylar fracture found no functional deficit and can be corrected via planned geometric osteotomy at a later date, if required.[61] The incidence and long-term consequences of cubitus varus deformity in LMICs have not been investigated in the current literature.

Traction is well documented to result in a longer hospital stay than operative intervention. In our review, a total of 13 studies specify the length of hospital stay when managed by traction. If not otherwise stated, the total duration of traction was taken as the length of hospital stay. Duration of inpatient stay was in the range of 11–22 days with a median of 19 days. Two papers used length of stay as contributing factors of their cost analysis, both concluding traction was considerably more expensive than pinning.[8,53] When considering duration of stay, theatre fees, anaesthetic fees, recovery room fees and radiography fees, Sutton et al. and Piretto et al. calculated traction was more expensive by 142% and 179%, respectively. However, both papers were based in high-income countries, where costs of both equipment and service provision make calculations non-transferable to less economically developed nations.

The use of traction for Gartland types II and III supracondylar fractures provides a safe and effective alternative to percutaneous wire fixation in the resource-poor setting. In countries where few specialist centres are managing increasingly high volumes of trauma, the benefit of such surgical intervention remains to be proven. With the correct expertise, traction can be safely applied in a local setting, avoiding the need for long-distance transfer and associated financial cost. All papers in our review analysing long-term outcome measures of traction alone support this premise.

Currently there is no Level-1 evidence comparing percutaneous pin fixation with traction for displaced supracondylar fractures of the distal humerus in children. Drawing on conclusions from the studies in this review, there is a suggestion that these two management options remain in clinical equipoise. Our review also highlights the lack of data from LMICs on this topic, which would improve the transferability of our conclusions.

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Supplementary Material

Supplemental files are available online.

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